3.3.6 GEOLOGY AND SOILS

Issues	Potentially Significant Impact	Less Than Significant With Mitigation Incorporated	Less Than Significant Impact	No Impact
Would the project:				
(a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
(i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? (Refer to Division of Mines and Geology Special Publication 42.)	☐	☐	☐	☒
(ii) Strong seismic ground shaking?	☐	☐	☒	☐
(iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
(iv) Landslides?	☐	☐	☐	☒
(b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☒	☐
(c) Be located on geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒

Issues	Potentially Significant Impact	Less Than Significant With Mitigation Incorporated	Less Than Significant Impact	No Impact
(d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
(e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?	☐	☐	☐	☒

Environmental Setting

Regional Setting

The Coscol Marine Terminal Deconstruction and Pipeline Abandonment Project (proposed Project) site lies within the geologically complex region of California referred to as the Coast Ranges geomorphic province.[1] The Coast Ranges province lies between the Pacific Ocean and the Great Valley (Sacramento and San Joaquin Valleys) provinces and stretches from the Oregon border to the Santa Ynez Mountains near Santa Barbara. Much of the Coast Range province is composed of marine sedimentary deposits and volcanic rocks that form northwest trending mountain ridges and valleys, running subparallel to the San Andreas Fault Zone. The relatively thick marine sediments dip east beneath the alluvium of the Great Valley. The Coast Ranges can be further divided into the northern and southern ranges, which are separated by the San Francisco Bay. The San Francisco Bay lies within a broad depression created from an east-west expansion between the San Andreas and the Hayward Fault systems. West of the San Andreas Fault lies the Salinian Block, a granitic core that extends from the southern end of the province to north of the Farallon Islands.

The Northern Coast Ranges are comprised largely of the Franciscan Complex or Assemblage, which consists primarily of graywacke, shale, greenstone (altered volcanic

[1] A geomorphic province is an area that possesses similar bedrock, structure, history, and age. California has 11 geomorphic provinces.

rocks), basalt, chert (ancient silica-rich ocean deposits), and sandstone that originated as ancient sea floor sediments. Franciscan rocks are overlain by volcanic cones and flows of the Quien Sabe, Sonoma and Clear Lake volcanic fields. The San Francisco and San Pablo Bays including shoreline areas are generally comprised of soft compressible sediments known as Bay Mud, which can be very thick in areas.

The proposed Project is located in the seismically active San Francisco Bay region that is situated on a plate boundary marked by the San Andreas Fault System, which consists of several northwest trending active and potentially active faults, as shown on Figure 3.3.6-1. In the Bay Area, movement along this plate boundary is distributed across a complex system of strike-slip, right-lateral, parallel and sub-parallel faults. These faults include the San Andreas, Hayward, Rodgers Creek-Healdsburg, Concord-Green Valley, Greenville-Marsh Creek, Calaveras, and West Napa Faults.

Project Setting

Geology

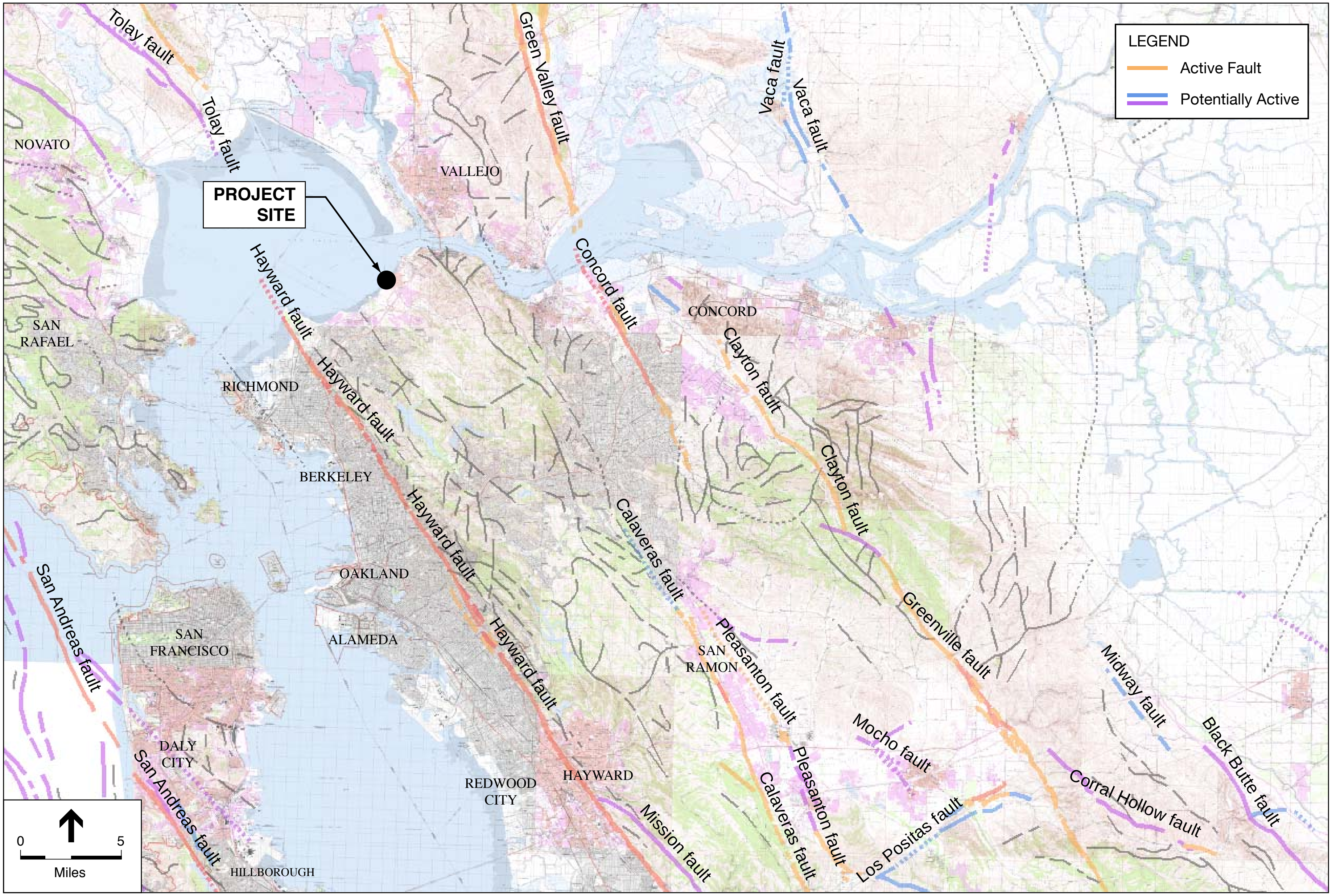
The proposed Project site is located in northern Contra Costa County along and within the southeastern edge of San Pablo Bay. Geologically, this region of California is characterized by a series of northwest trending mountains and valleys controlled by tectonic folding and faulting. The region has undergone a complex geologic history of folding, faulting, uplift, sedimentation, volcanism, and erosion.

The region is characterized primarily by sedimentary rocks, occasional volcanic rocks, and alluvial deposits. Regional basement rocks consist of the highly deformed Great Valley Sequence, which include massive beds of marine sandstone intermixed with siltstone and shale, and marine sandstone and shale overlain by soft non-marine units. Unconsolidated alluvial deposits, artificial fill, and estuarine deposits underlie the marginal areas along the San Pablo Bay, Carquinez Straight, and Suisun Bay.

Faults and Seismicity

The proposed Project lies within a region of California that contains many active and potentially active faults and is considered an area of high seismic activity (Figure 3.3.6-1).[2]

[2] An "active" fault is defined by the State of California as a fault that has had surface displacement within Holocene time (approximately the last 11,000 years). A "potentially active" fault is defined as a fault that has shown evidence of surface displacement during the Quaternary (last 1.6 million years), unless direct geologic evidence demonstrates inactivity for all of the Holocene or longer. This definition does not, of course, mean that faults lacking evidence of surface displacement are necessarily inactive. "Sufficiently active" is also used to describe a fault if there is some evidence that Holocene displacement occurred on one or more of its segments or branches (Hart, 1997).



SOURCE: Jennings, 1994

Coscol Marine Terminal MND . 208518

Figure 3.6-1
Regional Fault Map

The United States Geological Survey (USGS) along with the California Geological Survey and the Southern California Earthquake Center formed the 2007 Working Group on California Earthquake Probabilities, which has evaluated the probability of one or more earthquakes of magnitude 6.7 or higher occurring in the State of California over the next 30 years. The result of the evaluation indicated a 63 percent likelihood that such an earthquake event will occur in the Bay Area (USGS 2008).

Richter magnitude is a measure of the size of an earthquake as recorded by a seismograph, a standard instrument that records groundshaking at the location of the instrument. The reported Richter magnitude for an earthquake represents the highest amplitude measured by the seismograph at a distance of 100 kilometers from the epicenter. Richter magnitudes vary logarithmically with each whole number step representing a ten-fold increase in the amplitude of the recorded seismic waves. Earthquake magnitudes are also measured by their Moment Magnitude (Mw) which is related to the physical characteristics of a fault including the rigidity of the rock, the size of fault rupture, and movement or displacement across a fault (CGS 2002).

Ground movement during an earthquake can vary depending on the overall magnitude, distance to the fault, focus of earthquake energy, and type of geologic material. The composition of underlying soils, even those relatively distant from faults, can intensify ground shaking. For this reason, earthquake intensities are also measured in terms of their observed effects at a given locality. The Modified Mercalli (MM) intensity scale (Table 3.3.6-1) is commonly used to measure earthquake damage due to ground shaking. The MM values for intensity range from I (earthquake not felt) to XII (damage nearly total), and intensities ranging from IV to X could cause moderate to significant structural damage.[3] The intensities of an earthquake will vary over the region of a fault and generally decrease with distance from the epicenter of the earthquake.

The site could be subjected to damage from movement on any one of the active Bay Area earthquake faults. The Refinery is located approximately mid-way between the active Hayward and Concord-Green Valley faults, as shown on Figure 3.3.6-1. Table 3.3.6-1 lists the nearest active and potentially active faults, Maximum Credible Earthquake (MCE), and the probability of occurrence.

[3] The damage level represents the estimated overall level of damage that will occur for various MM intensity levels. The damage, however, will not be uniform. Not all buildings perform identically in an earthquake. The age, material, type, method of construction, size, and shape of a building all affect its performance (ABAG 1998a).

Table 3.3.6-1. Active Faults in the Project Site Vicinity

Fault	Location and Direction from Refinery	Recency of Movement	Fault Classification[a]	Historical Seismicity[b]	Maximum Moment Magnitude Earthquake (Mw)[c]
Hayward	7 miles southwest	Pre-Historic (possible 1836; 1868 ruptures) Holocene	Active	M6.8, 1868 Many <M4.5	7.1
West Napa	8 miles north	Holocene	Active	Not Applicable	6.5
Concord-Green Valley	9 miles east	Historic (1955) Holocene	Active	Historic active creep	6.9
Rodgers Creek	12 miles northwest	Historic Holocene	Active	M6.7, 1898 M5.6, 5.7, 1969	7.0
Pleasanton	22 miles southeast	Holocene	Active	Not Applicable	5.5
San Andreas	25 miles west	Historic (1906; 1989 ruptures)	Active	M7.1, 1989 M8.25, 1906 M7.0, 1838 Many <M6	7.9
Calaveras (northern)	25 miles southeast	Historic (1861 rupture) Holocene	Active	M5.6-M6.4, 1861 M4 to M4.5 swarms 1970, 1990	6.8
Marsh Creek-Greenville	28 miles southeast	Historic (1980 rupture) Holocene	Active	M5.6 1980	6.9

[a] See footnote 2.

[b] Richter magnitude (M) and year for recent and/or large events. The Richter magnitude scale reflects the maximum amplitude of a particular type of seismic wave.

[c] Moment magnitude is related to the physical size of a fault rupture and movement across a fault. Moment magnitude provides a physically meaningful measure of the size of a faulting event (CGS 2002). The Maximum Moment Magnitude Earthquake (Mw), derived from the joint CGS/USGS Probabilistic Seismic Hazard Assessment for the State of California, 1996 (Peterson 1996).

Source: Jennings 1994; Hart 1997

The closest active fault to the Refinery is the Hayward fault, located approximately 7 miles to the southwest. The Hayward Fault Zone is the southern extension of a fracture zone that includes the Rodgers Creek fault (north of San Pablo Bay), the Healdsburg fault (Sonoma County), and the Maacama fault (Mendocino County). The Hayward fault trends to the northwest within the East Bay, extending from San Pablo Bay in Richmond, 60 miles south to San Jose, where it converges with the Calaveras fault, a similar type fault that extends north to Suisun Bay. Historically, the Hayward

Fault generated two sizable earthquakes, both in the 1800s. The USGS Working Group on California Earthquake Probabilities includes the Hayward–Rodgers Creek Fault Systems in the list of those faults that have the highest probability of generating earthquakes of M 6.7 and greater.

Ground movement intensity during an earthquake can vary depending on the overall magnitude, distance to the fault, focus of earthquake energy, and type of geologic material. Areas that are underlain by bedrock tend to experience less ground shaking than those underlain by unconsolidated sediments such as artificial fill. In general, bedrock areas would experience ground shaking of higher frequency, shorter period, and lower amplitude. Structural damage resulting from shaking tends to be worse for structures located on unconsolidated deposits. Earthquake groundshaking may have secondary effects on certain foundation materials, including liquefaction and seismically induced settlement.

Seismic Hazards

Seismic hazards include groundshaking, liquefaction, lateral spreading, differential settlement, landsliding, and inundation by encroaching waves (tsunami and seiches). There are no known active faults traversing the Project site and therefore, fault rupture is not considered a potential geologic hazard that could affect the proposed Project.

Liquefaction

Liquefaction is the sudden temporary loss of shear strength in saturated, loose to medium-density granular sediments subjected to ground shaking. It generally occurs when seismically-induced ground shaking causes the pressure of the water between the granules to increase to a point equal to the pressure of the soil overburden. When this occurs, the soil can move like a fluid, hence the term liquefaction. Liquefaction can cause foundation failure of buildings and other facilities due to the reduction of foundation bearing strength.

The potential for liquefaction depends on the duration and intensity of earthquake shaking, particle size distribution of the soil, density of the soil, and elevation of the groundwater. Areas at risk due to the effects of liquefaction are typified by a high groundwater table and underlying loose to medium-density granular sediments, particularly younger alluvium and artificial fill. According to the Association of Bay Area Governments (ABAG) Liquefaction Susceptibility Map, the land-based portions of the

Project have a very low risk of liquefaction (ABAG 2008). The mapping does not include submerged areas of the bay.

Other Geologic Hazards

Soil Erosion. Soil erosion is the process whereby soil materials are worn away and transported to another area either by wind or water. Rates of erosion can vary depending on the soil material and structure, placement and human activity. The erosion potential for soils is variable throughout the proposed Project area. Excessive soil erosion can eventually lead to damage of building foundations, roadways and dam embankments. Erosion is most likely on sloped areas with exposed soil, especially when unnatural slopes are created by cut and fill activities. Soil erosion rates can therefore be higher during the construction phase. Typically, the soil erosion potential during construction is reduced by using modern construction practices; once an area is graded and covered with concrete, structures, asphalt, or vegetation, the soil erosion potential is nearly eliminated.

Landslides. Landslides are dependent on the slope and geology of an area as well as the amount of rainfall, excavation, and seismic activity. A landslide or slope failure is a mass of rock, soil, and debris displaced downslope by sliding, flowing, or falling. Steep slopes and downslope creep of surface materials characterize landslide-susceptible areas. Landslides can occur on slopes of 15 percent or less; however, the probability is greater on steeper slopes, with old landslide deposits being the most likely to experience failure. Landslides typically occur within slide-prone geologic units that contain excessive amounts of water.

Regulatory Setting

Federal

There are no applicable Federal regulations that would apply to the proposed Project related to geology and soils.

State

There are no applicable State regulations that would apply to the proposed Project related to geology and soils.

Local

Contra Costa County General Plan

Contra Costa County has established goals, policies, and programs in regards to geologic hazards. These are outlined in the Conservation and Safety Element sections of the Contra Costa County General Plan (Contra Costa County 2005). These goals and policies are generally intended to minimize geologic hazards for proposed developments. The proposed Project, however, does not include the construction of any structures for human occupancy and therefore none of the policies apply to the proposed Project.

Impact Analysis and Mitigation

Impact Discussion

(a.i) The proposed Project does not lie within or near an Alquist Priolo Earthquake zone and would have a very low potential for fault rupture to occur near any of the Project elements. Therefore, there would be no impact from fault rupture. (No Impact)

(a.ii) The San Francisco Bay Area is considered to be a very seismically-active region. The Project site is located in an area subject to significant groundshaking from an earthquake along any of the active faults located in the region including the San Andreas and the Hayward Fault, the closest fault to the Project site. However, the proposed Project does not include construction of any habitable structures that could potentially be damaged or cause injury or death. Workers may be subject to groundshaking in the event that a significant earthquake occurred during the decommissioning program, but the likelihood of this occurring during the relatively short (less than six months) deconstruction period is relatively remote. Therefore, the potential impact from groundshaking is less than significant. (Class III)

(a.iii) Mapping compiled by the Association of Bay Area Governments shows that the land-based work sites of the Project are located in an area mapped as having a very low potential for liquefaction. Bay Mud deposits commonly have saturated sandy lenticular lenses associated with them that can be liquefiable. The marine terminal may be founded on liquefiable materials. However the proposed Project would remove these materials. In addition, the proposed Project does not include the construction of any habitable structures that could potentially be damaged or cause injury or death as a result of liquefaction. Therefore, there is no potential impact from liquefaction. (No Impact)

(a.iv) The land-based portions of the Project site are relatively level and would not be subject to any landslides. No impact would result. (No Impact)

(b) The proposed Project's deconstruction activities would consist primarily of offshore work associated with demolition of the existing Marine Oil Terminal, which would not disturb surface soils. The land-based portions of the proposed Project include abandonment of seven subsurface pipelines and a vault. The pipelines would be grouted and the concrete of the vault removed. Following pipeline grouting and vault removal, the vault area would be backfilled with imported soil. Construction projects that disturb more than an acre require erosion control measures to protect topsoil. The proposed Project, by comparison, would disturb a very small area (approximately 600 to 1000 square feet maximum) associated with the vault and would only require minimal earthwork activities. In addition, all work would be conducted with the use of industry standard Best Management Practices which limit the amount of erosion, i.e., project scheduling that avoids storm events, protection of any stockpiled material, etc., and therefore, would have a less than significant impact related to erosion and loss of topsoil. (Class III)

(c) The proposed Project does not include the construction of any habitable structures that require a foundation. The only other activities associated with the Project, other than demolition of existing facilities, is the placement of fill in the land-based vault following pipeline grouting and concrete removal. Therefore, there would be no impact to the proposed Project area from unstable soils including landslides (also discussed above), lateral spreading (related to liquefaction which is also discussed above), subsidence, liquefaction, and collapse. (No Impact)

(d) Expansive soils exhibit volumetric changes between wetting and drying cycles over the long-term, which can damage foundations. The proposed Project does not include any aboveground improvements that would be susceptible to the effects of expansive soils. No impact to the proposed Project would result. (No Impact)

(e) No septic tanks or alternative wastewater systems are proposed for the Project. No impact would result. (No Impact)